DEVELOPMENT OF CONTEXTUAL-BASED SCIENCE DIGITAL STORYTELLING TEACHING MATERIALS TO IMPROVE STUDENTS' CRITICAL THINKING ON CLASSIFICATION THEME

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DEVELOPMENT OF CONTEXTUAL-BASED *SCIENCE DIGITAL STORYTELLING* TEACHING MATERIALS TO IMPROVE STUDENTS' CRITICAL THINKING ON CLASSIFICATION THEME

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ABSTRACT

This study aims to determine the feasibility and effectiveness of contextual-based *Science Digital Storytelling* (SDS) teaching materials. This research used Research and Development model. The analysis of potentials and problems were drawn from the lack of learning media usage in Junior High School. The interviewee stated that the provided infrastructure facilities are adequate for utilizing instructional media. Media experts and material experts validated SDS learning media. The average validation results of media experts and material experts were respectively 95.83% and 93.94% (very feasible). The average results of SDS media's readability and usage by students were 76.71% (feasible) and 95.34% (very feasible). The effectiveness of media was measured through pretest and posttest then calculated its increase with the N-gain and significance through the t-test. The results showed that every aspect of critical thinking has increased with an N-gain average of 0.44. The increase was significant in term of t-test score. In conclusion, contextual-based SDS learning media can improve students' critical thinking ability.

Key Words: *Science Digital Storytelling*, contextual, critical thinking.

INTRODUCTION

Today, science education is more critical and has a different purpose than in the past. Science is everywhere and involved in the workforce in the high-tech economy, the survival of the world in the industrial revolution 4.0, and to face the challenge in the education of large, diverse fraction of population. Science education plays essential roles in the development of science literacy, scientific methodology, scientific concepts, and science process skills of people in a technologically and scientifically advanced world. Therefore, in facing the disruption era, the rapid development of education leads the 21st-century teachers to improve their professional skills (Dewi, 2012). They must follow the progress by fundamental changes in applying and delivering science materials to the students (Rahayu and Laksono, 2015). Teachers are demanded to design conducive, exciting, fascinating learning activities to enhance students' participation in discovering theories and facts through scientific approaches.

The application of various media in science learning is crucial since it can motivate students' willingness to study (Ali, 2009). However, the results from an observation done in several junior high schools in Semarang, Central Java Province, Indonesia showed that science learning method is still monotonous through traditional lecturing method without any media or teaching aids. Also, the preliminary identification of potentials and problems of science learning of the junior high schools in Semarang showed that learning media in the form of videos are rarely employed even though the schools have the supporting devices such as computer laboratory, LCD projector, and active speakers. Another case in Pekalongan, Central Java Province Indonesia, there is a problem of the students' low learning achievement because of lack of media utilization during the learning process. Moreover, the conventional lecturing method also causes the learning process to be teacher-centered learning, lack of students' activities, and resulting in an only recording-copying activity. Herman (2007) explained that such learning activities are not able to improve students' skill in problem-solving, reasoning, connecting, and mathematical communication. Also, the students' critical thinking ability is low since the traditional learning technique, which is performed by the teacher keeps the students to have a low level of thinking ability. Kurniawati et al. (2014) stated that students' critical thinking is inadequate because of the lack of learning media utilization.

Media could help the students to learn abstract concepts and improve students' learning outcomes (Taufiq et al., 2014; Maharani & Dewi, 2015). Learning media such as integrated science e-book (Pramana & Dewi, 2014), electronic portfolio media (Dewi &

Akhlis, 2016), Science Digital Module (Digimon) by Syahroni et al. (2016), ICT-based learning media (Akhlis & Dewi, 2014) are verified in improving students' learning outcomes. Those media are ICT-based learning media, which is one of the ways to pursue effective and active learning (Cimer, 2007). ICT Literacy of students is higher and more significant in all factors than the teacher (Moradi-Rekabdarkolaei, 2011).

Either teachers or the students must be equipped with the 21st-century skills to be able to compete in today's era. Rotherham & Willingham (2009) stated that students' success depends on acquired 21st-century skills. In this focus of the study, the developed media is the Science Digital Storytelling (SDS) as an attractive learning media that can be used in the learning process. SDS is an art of storytelling by combining various digital multimedia, such as text, images, narrative recordings, audio, video, and music (Maddin, 2011). The SDS has not been developed mainly in science learning. Robin (2008) stated that SDS is a flagship media to grow the 21st-century skills among students. Suwardy et al. (2013) said that SDS could improve students' ability in connecting learned theories to experienced cases. It is in line with the research done by Botturi et al. (2014) and Niemi (2014) who explained that the use of SDS in learning process would enhance students' quality through emerging the 21st-century skill among them.

SDS media needs to be applied to a science lesson to improve students' metacognitive competence (Dewi et al., 2017). Considering the importance of SDS, thus, it requires to be developed to enhance students' critical thinking. SDS is developed with contextual-based, which can enhance students' critical thinking (Komalasari, 2012). Experience-based learning is used to boost students' achievement and skills of science process (SSP) (Alkan, 2016). It concluded that contextual-based SDS media on classification theme requires to be developed in science learning. Therefore, the objective of this study is to describe media characteristics, to analyze media appropriateness, and to analyze the effectiveness of contextual-based SDS learning media in improving students' critical thinking ability.

The problems of this research are:

1. What are the characteristics of contextual-based Science Digital Storytelling (SDS) learning media on classification theme?
2. How is the appropriateness of contextual-based Science Digital Storytelling (SDS) learning media on classification theme?
3. Is contextual-based Science Digital Storytelling (SDS) learning media effective in improving student' critical thinking on classification theme?

METHODS

Research Design

This is a Research and Development study which resulted in a developed product of Contextual-Based *Science Digital Storytelling* Teaching Materials

The employed development and research method were the modification of Sugiyono's (2015) ten developmental steps: (1) potential and problem identification; (2) early data collection; (3) SDS media design; (4) validation of SDS media design ; (5) revision of SDS media design; (6) SDS limited-scale trial; (7) SDS media revision I; (8) SDS large-scale trial; (9) SDS media revision II; and (10) massive production.

Population and Sample

The research was conducted in junior high school. The research population was all 7th-grade students in an odd semester, the academic year of 2017/2018. The sample was selected employing the random sampling technique where the sample was taken without consideration of the strata existed in the population. After that, the homogeneity and normality test was performed to reveal the sample's initial state. There were two research groups. 10 students were on the small-scale trial group while 32 students on the large-scale trial group.

Data Colection

The obtained data were characteristics, appropriateness, and effectiveness of the media. The employed methods to collect data were an interview, questionnaire, and test. On the observation stage, the interview method was conducted with 10 students at 7th grade in school and two science teachers of the school. The questionnaire method was intended to know the characteristics and appropriateness of Science Digital Storytelling (SDS) media. The questionnaire instruments used were: (1) media validation questionnaire for media and material experts, given on design validation stage, and (2) readability and usage questionnaire by students, given on small-scale and large-scale trial. Before being used to collect data, the questionnaire instrument was validation by experts. The validation used in this research consists was both the media and material expert validation. The media experts were one science lecturer of Faculty of Mathematics and Natural Science, Universitas Negeri Semarang, and two junior high schools teachers. Also, the material experts were one science lecturer of Faculty of Mathematics and Natural Science, Universitas Negeri Semarang, and two junior high school teachers. The experts employed in this study lead to the validity of the research.

Data Analysis

The validation results assessed by media and material experts were converted into validation criteria, as seen in Table 1.

Table 1. Expert Validation Assessment Criteria

Percentage	Criteria
81,25% < score ≤ 100%	Very Feasible
62,50% < score ≤ 81,25%	Feasible
43,75% < score ≤ 62,50%	Fair
25,00% ≤ score ≤ 43,75%	Less

The employed test methods were pre-test and post-test in the form of grounded multiple choice. Before being assigned during pre-test and post-test, the questions were tested to participants that had received materials on classification theme to obtain the validity and reliability of the items. The validity of test items was examined using the product moment correlation while the reliability was tested using the Cronbach Alpha formula. The used test instruments (grounded multiple choice) were valid and reliable, with 0.555 of validity value and 0.79 reliability value. The analysis through N-gain (Hake, 1999) and Significance T-test were done to know the increase of critical thinking. The N-gain criteria can be observed in Table 2.

Table 2. Assessment Criteria for Critical Thinking

g Value	Criteria
g < 0,3	Low
0,3 ≤ g < 0,7	Medium
g ≥ 0,7	High

RESULTS

The developed SDS in the form of a short film aiming at delivering information about object and living thing classification is declared excellent and useful in learning processes when achieving several components. According to Robin (2017), there are seven components in digital storytelling, which are the point of view, dramatic question, emotional content, voice, soundtrack, economy, and pacing. The SDS was developed, referring to Robin's (2017) seven components to enhance learning quality. Point of view contains prior information about the story revealing what knowledge students will gain. This new information is presented in the title and subject matter.

Figure 1. *Point of view*

Dramatic question carries provoking questions to arouse students' curiosity and direct them in obtaining information.

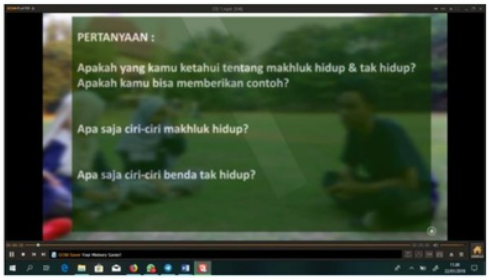

Figure 2. *Dramatic question*

Emotional content presents story or information modestly and variedly to prevent students from boredom.

Figure 3. *Emotional content*

Voice should be clear and appropriate with the story. The produced SDS voice is indeed clear, and the words are translucently pronounced. This was the result of clip-on usage by the players during the recording.

Soundtrack is music inserted in the media functioning as a supportive element in delivering information. The SDS soundtrack varied depending on each scene, mostly cheerful and upbeat ones.

Economy is time management to compile all information to be delivered in accordance with the purpose and target. The duration of SDS ranges from 10-15 minutes, and this intends to not make students get bored so that materials and learning objectives are conveyed effectively.

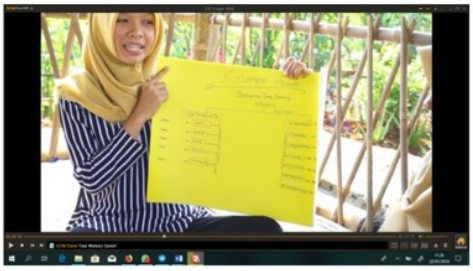

Figure 4. *Economy and Pacing*

Pacing is spaces of the presentation. In the SDS media, each piece of information has a space between 20-30 seconds before the next information comes up. Spaces provide students opportunities to grasp the given knowledge before getting further information.

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The characteristics of media could be identified through a validation letter by the media and material experts in addition to questionnaires of media's readability and usage by the students. The validation letter by the experts declared that SDS media are made up of a combination of text, sound, and mobile media with the time duration between 15-20 minutes and have a consistent presentation, simple, and suitable with the presented material. Questionnaires of media's readability and usage by the students declared that SDS media has bright pictures, readable text, supportive music, and appropriate duration with covered materials, exciting presentation, systematic and vivid materials, provoking curiosity, related to daily life, a clear plot and suitable for Junior High School students' thinking level.

The SDS media validated by the experts were said to be feasible if it achieves >62.50% (Arikunto, 2012). The validation instrument by the media experts consists of 4 aspects. Assessment of each element of the feasibility of the media is shown in Table 3.

Table 3. The Assessment of Each Feasible Aspect of Media by Media Experts

Assessed Aspects	Average (%)	
	1st Validation	2nd Validation

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	1st Validation	2nd Validation
A. Software Engineering Aspect		
1. Maintainable	91.67	100.00
2. Usability	91.67	100.00
3. Effective and efficient	100.00	100.00
B. Audio Communication Aspect		
1. Communicative	75.00	83.33
2. Narration	100.00	100.00
3. Back-sound	75.00	83.33
C. Visual Communication Aspect		
1. Text	91.67	100.00
2. Color alignment	83.33	100.00
3. Motion media	91.67	100.00
D. Others		
1. Interactivity	91.67	100.00
2. Time	75.00	91.67
3. Artistic and aesthetic	91.67	91.67
Average percentage	**88.19**	**95.83**
Criteria	**Very feasible**	**Very feasible**

Table 3 explains that there was an increasing percentage of each aspect, from the first validation to the 2nd validation. The validation instrument by the material experts consists of 6 points. Assessment of each element of material's feasibility can be seen in Table 4.

Table 4. The Assessment of Each Feasible Aspect of Media by Material Experts

No. Indicators	Average (%)	
	1st Validation	2nd Validation
A. Material Scope		
1. Completeness	91.67	100.00
2. Depth	91.67	100.00
B. Accuracy		
1. Fact accuracy	83.33	100.00
2. Concept accuracy	75.00	83.33
C. Recency and Contextual		
1. Recency of the features	83.33	83.33
2. Real life context	100.00	100.00
D. Presentation		
1. Consistency of Systematic Presentation	91.67	83.33
E. Material Presentation Support		

No.	Indicators	Average (%)	
		1st Validation	2nd Validation
	1. Illustration accuracy	91.67	91.67
F.	**Learning Presentation**		
	1. Students' active participation	100.00	100.00
	2. Supportive skills during the learning process	91.67	91.67
	3. Critical thinking skill	91.67	100.00
Average percentage		**90.15**	**93.94**
Criteria		**Very feasible**	**Very feasible**

Table 4 explains that each aspect had an increase or a fixed percentage of first validation to the 2nd validation. Then, the small-scale and large-scale trial were done. The results of both experiments showed that the readability and usage of SDS media reached an average percentage of 90.15% (very feasible) and 93,94% (very feasible). The analysis used to find out the increase in students' critical thinking was through N-gain (Hake, 1999) and Significance T-test. Counting the N-Gain was employed to know the significant improvement of students' critical thinking on each aspect. The result can be seen in Figure 1.

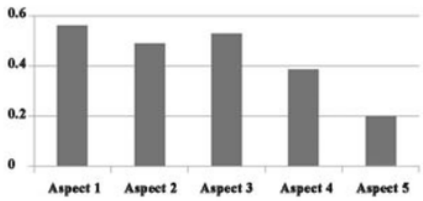

Figure 5. N-Gain Results on Each Aspect of Critical Thinking Skill

Information:

Aspect 1: Giving the simple explanation

Aspect 2: Building basic skill

Aspect 3: Concluding

Aspect 4: Giving the further explanation

Aspect 5: Setting up strategies and tactics

(Ennis, 2011)

Figure 5 shows that there was an increase in the students' critical thinking skills after experiencing learning with SDS. The occurred increase in this research was categorized as a medium and low improvement; these categories were based on the criteria displayed in Table

2. The result of pretest and posttest also calculated its significance via t-test. The calculation results are presented in Table 5.

Table 5. The Significance Test on the Improvement of Critical Thinking Skill

Data	Average	Md	$\sum x^2 d$	t_{count}	t_{table}	Category
Pretest Score	35.867	40.467	17361.470	9.059	2.045	Significant
Posttest Score	76.333					

Table 3. shows that the price of t_{count} was more significant than the price of t_{table}; therefore, it concluded that there was a considerable increase in the students' critical thinking skills on classification theme using SDS.

DISCUSSION AND CONCLUSION

Characteristics of SDS *Media*

Validation letter of media by media and material experts, the questionnaire of readability and usage of the media by the students revealed that SDS had fulfilled the seven components by Robin (2017). The elements or characteristics are the point of view, dramatic questions, emotional content, voice, soundtrack, economy, and pacing. The media's point of view is seen from the entrance of the title, resulting in the clear and systematic presentation of the materials which was corresponded to the determined learning objectives.

The dramatic questions consist of provoking questions to lead students to find out information independently. The items were displayed before the presentation of materials so that students were curious. Emotional content is a variation of the story used in this media. The given story was simple, varied, and contextual resulting in a clear and easily-understood plot.

The sound in the media is one of the components that should be considered in making SDS. The developed SDS media has clear sound so that students could comprehend it thoroughly. The soundtrack is inserted in the media to create fascinating SDS. The soundtrack did not distract students' attention and is in line with the materials.

Time management or economy on developing SDS media has been in alignment with the delivered materials, namely between 15-20 minutes. The last component of SDS is pacing, a transition of information. The pacing in SDS is in the form of pauses given at the turning scene, with cheerful font and color, and acceptable contrast.

Other characteristics of the developed SDS media are: (1) the given materials are classification theme, (2) contextual content, (3) the media could improve students' critical

thinking skill, (4) the media could boost students to find information independently, (5) easy to use and maintain, (6) the media could be adopted as an independent learning media for students, (7) exciting alignment of pictures, sound, and writing (audiovisual media) makes it proportional.

Th e feasibility of Contextual-based SDS Media

The media was evaluated until the experts declared that SDS media were feasible to be assigned to trials without no more revision, comment, or suggestion. There were two stages of validations. Table 1 shows that it was obtained the average value of each aspect, 88.19% (very feasible), by media experts. They stated that SDS media needs development in terms of (1) adding a title, (2) requiring more characters, (3) selection of cheerful font and color, (4) duration, (5) contrasting background of the text, (6) neat narrative, (7) appropriate back sound selection, (8) louder voice for some characters, (9) fixing the typographical error.

Those suggestions were used as a guide to improve the media. It needed a title for students to know the headline of the materials. More characters were required to make it more interesting. Additionally, the media are supported by various kinds of cheerful font and color. The word 'cheerful' here means multiple, up to date, and friendly for teenagers.

The next suggestion was for the duration, which is needed to be extended to enhance the readability and understandably of the displayed text. Also, students could take some notes on the essential materials during the video presentation. Students' comprehension is supported by a contrasting background of the text, neat narrative, appropriate back sound, clear characters' voice, and proper typing. Those deficiencies have been fixed for students to comprehend the given materials through SDS media in the theme of classification.

After editing the media, the revised version of the media is more interesting, clear, and feasible for trials without any revisions. Material validation was also done in 2 stages. However, expert 2 stated that SDS media needed correction. Things to be revised were: (1) adding supportive illustration (short video, text, or picture), (2) combining materials such as homogeneous or heterogeneous compounds, and molecular elements or molecular compounds. The suggestions were used as a guide for improving the media. By adding illustration and materials, it was expected that the media could cover all basic competencies. Figures are used to help students understanding the materials.

SDS media has been revised as suggested. After that, validation stage 2 was done by media expert 2. The increase occurred since the presented materials are complete, precise, and clear. The small-scale trial was done by presenting SDS media to the students and explaining

to them about its content and how to use it. Furthermore, the students filled the questionnaire of readability to find out their response to its layout and readability.

The students had a suggestion after the small-scale trial had done. The advice was about the suitability of the text with the scene and has been fixed. The SDS media at a small-scale trial stage was declared as feasible. The statement was the opinion of media and material experts that the SDS media had been eligible to be applied in large-scale trial and in learning as well.

In the large-scale trial, learning was done by the instructional tools arranged using the developed media. The lesson used a contextual approach, inquiry model with the method of watching SDS media film. After that, the students filled out a questionnaire to reflect their media usage experiences. All statements were positive and at a very feasible level. In this large-scale trial, there were no suggestions or comments about the media. Therefore, SDS media is worthy of use in the learning process.

The results of usage questionnaire by the students showed that contextual-based SDS media on classification theme could facilitate students in learning, encourage them to independently find information, provoke curiosity, build liveliness, improve students' concepts mastery, improve students' critical thinking skills, and increase motivation in learning science.

The Effectiveness of Contextual-based SDS Media

Based on a study by Yang and Wu (2012), SDS Media in learning English can improve students' academic achievement, critical thinking, and learning motivation. Contextual-based SDS media on the theme of classification should be tested for its feasibility and effectiveness. It is in line with the purpose of R & D research, which is to produce a specific product and test its efficacy (Sugiyono, 2015). The analysis of the effectiveness of SDS media was conducted at a large-scale trial.

The provided treatments successfully improved students' critical thinking skills on classification theme. The aspect that experienced the highest increase was the first, while the lowest growth was the fifth in the low category. A more detailed explanation of the five elements is as follows. The first aspect is to provide a simple explanation. Indicators taken here are asking and answering questions of clarification and challenging questions. The meaning of these indicators is that learners can ask other students or teachers and answer questions asked by the teacher.

Wahyuni (2011) stated that one of the characteristics of learners who have critical thinking skill is that they can make questions and deliver them precisely. There can be said

that the learners have achieved this indicator because of the learning through SDS media; there was an increase in participation to ask and answer questions. The first aspect experienced the highest growth compared to other aspects of the study because learners were accustomed to conducting discussion activities in learning.

One of the components of SDS media is dramatic questions. These questions provoke learners to ask questions and answer questions that result in a discussion. Students are more motivated in learning when involved directly in the learning process that utilizes the media with the help of discussion methods (Nugroho et al., 2013).

The second aspect is building basic skills. The indicators used were observation and considering a report result of observation. The success of this indicator was demonstrated by the students' ability to respond to the worksheet and provide the right reasons for a chosen answer. This indicator can be achieved by the discovery of information of the students. SDS is a contextual learning medium and can encourage students to find their information (Dewi et al., 2018c). The statement is supported by the opinion of Putra (2013), which stated that one component of contextual learning is an inquiry.

Learning motivation will increase as students are directly involved in the discovery process to solve a problem (Aini et al., 2013). Stages that students did in looking for information were watching the SDS media, observing movies, and understand the material in the media. Further, the students were asked to do the worksheet properly, so that they have a better ability regarding considering the results of observation (Dewi et al., 2018b). The findings are supported via research conducted by Susantini & Qomariyah (2013), which proved that the method of video analysis assignment could develop the cognitive outcomes of learners.

The third aspect is concluding. The indicator used were, inducing and considering the induction result, also, making and determining consideration result. The success of students in achieving this indicator was shown by the ability of the students in concluding the materials being studied. Contextual-based SDS with inquiry model supports the problem-solving process that encourages learners to give a conclusion. The stages or syntax of inquiry models is the identification and determination of the problem scope, planning and predicting results, investigating and collecting data, interpreting data and developing conclusions, and reflecting. Students were ordered to observe SDS media, made predictions of the results then collected data information. In the process of collecting the data, the students found the answers to existing problems. The responses obtained later were developed into a conclusion.

Sutama et al. (2014) support the statement which explained that in concluding phase, students would include various critical thinking skills, namely logical thinking, inductive process, deductive process, evaluative, and ascribing logic argument in taking a conclusion. Teachers and students do a reflection on the learning process. It aims to know students' knowledge, adjusting students' concept mastery, and accomplish upcoming lesson activities.

The second indicator of the third aspect is making and determining the consideration result. This indicator has the highest N-gain value in this research. It was because of the use of contextual-based SDS media, which is considered to be exciting and easily understood.

Students will be more creative in solving the problem when they are directly involved (Sambada, 2012). Hughes (2014) stated that students who think critically have alternative thoughts and rational mindset and will always seek and explain solutions to existing problems. The developed SDS supports the contextual process of delivering information and materials, resulting in the capability of students to train their critical thinking.

The fourth aspect is giving further explanation. The indicator used was defining terms and considering a definition in three dimensions and identifying assumptions. The N-gain was obtained from the average N-gain of both indicators used. The students are said to achieve these indicators if they show their ability in defining terms, making a definition or argument.

SDS developed as an interesting learning source has several easy terms. A fascinating and intensive learning source could make a learning process more meaningful (Aulia, 2014). The learning emphasizes discovering materials and solutions for the faced problems.

Such a learning process could train students to make arguments and make them easily understand specific terms on the topic of classification. Perdani et al. (2015) stated that Senior High Schools students' critical thinking skill in science learning on sense system increased after being given the inquiry model of learning. It is in line with the research of Dewi et al. (2018), who proved that the inquiry model has a strong relation to students' critical thinking.

The second indicator of the fourth aspect is identifying assumption. This result showed the successful of contextual-based SDS media with an inquiry model. After the lesson, the students were able to analyze hypotheses or given assumptions, give an explanation in the form of argument, or draw a conclusion and proper opinion. The inquiry learning could enhance students' ability in explaining since they are ordered to discuss the correlation between hypotheses and observation result (Usdalifat et al., 2016).

The fifth aspect is setting up strategies and tactics. The indicator used was deciding an action. The result indicates that there was an increase in this aspect, although it was still low. The small increase was due to the unfavorable posttest time that collided with the impromptu

schedule of class clean-up. The ability of learners in determining an action was seen from the way of delivering the discussion results in front of the class, which should be thoughtfully and in a clear voice.

The use of contextual-based SDS media can be said to be successful since learners were encouraged to find the source as many as possible to solve an existing problem. When the students conveyed the results of the discussion in front of the class, they indirectly explored the material being studied. The results of the discussions were in the form of answers to the provided problems. The students who can take decisions or actions to solve problems indicated good critical thinking (Arifin, 2012). After knowing the improvement of critical thinking skill of each aspect, the level of significant growth in critical thinking before and after learning was measured using significance t-test. One of the reasons for the increasing ability to think critically is when learners are actively involved in the learning process (Siswono, 2005).

SDS media, which is being developed, was able to increase the students' activity in learning because the media cover contextual materials so that the students were interested in learning. SDS media was also able to encourage learners to find information. The description indicates that the use of contextual-based SDS media in inquiry learning on classification theme can significantly increase the students' critical thinking skill.

Conclusion

Based on the research results, it concluded that the developed SDS learning media have the characteristics of an audio-visual media and meet the seven components of good SDS. Contextual-based SDS learning media on classification themes were declared feasible as the science teaching media for junior high school in terms of media and materials aspect. Also, it is beneficial to improve students' critical thinking significantly.

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